Eugenics and Environment

BY

PROF. C. LLOYD MORGAN, LL.D., D.Sc., F.R.S.

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1919

To the Memory

of

FRANCIS GALTON

CONTENTS.

EUGENICS AND ENVIRONMENT.

CHAPTER I.

THE THREE COHORTS.

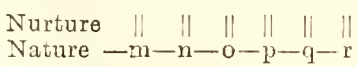
One must be blind to the patent facts of social life if one fails to see that thousands of children are born and bred under conditions which preclude their reaching a satisfactory level of physical and mental development. Anæmic, underfed, and overworked mothers too often bear to alcoholic husbands offspring who draw breath in an environment which, under the stress of poverty, through ignorance, or through wilful neglect, is hopelessly insanitary; and these unfortunate children are reared with little regard to the basal principles of hygiene or of ethics. From the mental point of view, the influence of home life leaves much to be desired. This lamentable state of matters we seek to remedy by all available means so far as conformable to our ethical ideals. But the practical problems which face us involve questions which lie within the province of the biologist to discuss. Heredity, for example, is at bottom a biological problem. It is true that the life-circumstances of human folk differ from those which form the environment of animals. It is true that social conditions involve factors which are superadded to the purely biological factors. None the less the biological factors are there and must be reckoned

Many Children Start Life Handicapped.

with. And the cardinal principles of heredity, so far as our knowledge goes, are the same for man and for the lower animals.

Nature and Nurture.

It is convenient at the outset to distinguish between nature and nurture so long as we bear in mind that, though they are distinguishable, they are inseparable. The one emphasises the hereditary relation and what is constitutional and inborn; the other emphasises the environment which affords the conditions under which the constitutional nature develops. Without these conditions there is no development. Let us express the matter diagrammatically:—



Here the letters stand for persons in genetic sequence. The horizontal lines stand for hereditary relations. The vertical double lines stand for the influence of environing conditions and circumstances as they affect each successive individual. A question at once arises: How far, if at all, does the relation to his environment, which modifies, say, *o*, under nurture, affect the hereditary relation between *o* and *p*? In other words: How far, if at all, is what *o* acquires, under nurture, transmitted to *p* so as to influence his nature? We shall have to consider what light biology throws upon this question.

We commonly say that the hereditary constitution of the individual depends upon heredity. But from the strictly scientific point of view this phrase "depends on heredity" is perhaps unfortunate. It looks as if there were a something, some special entity or force or principle, through the agency of which children

resemble their parents; something which makes them do so. Science fights shy of all such agencies. We smile indulgently at the supposed *vis dormitiva* in opium, or the "aqueosity" which makes water watery. But there are people who still say that memory enables us to remember, and that it is gravitation which causes the attraction of a falling stone to the earth. Science deals frankly with observed facts, and endeavours to express the general truths they exemplify. It is a general truth that unsupported stones do, as a matter of observed fact, fall to the ground, and that children *do* resemble their parents, in a measure that can be determined by careful investigation. In technical phrase, there is a correlation between the characters, mental and physical, in parents and offspring. Heredity is the group-name by which we label correlations of this particular kind. It is not an agency which brings them into being; it is the named concept under which they may be classified and discussed.

What is meant by Heredity?

We have, then, certain observable facts with regard to the nature or constitution which afford data for heredity correlation. We have also facts with regard to the influence of the environment that plays down upon this nature. And we have to consider the relation which obtains between what is given in nature and what is acquired through nurture, in the individual and in the community. What we mean by the individual is clear enough; we mean John Jones, William Smith, or Mary Robinson. What we mean by the community is not quite so clear. Technically it is not the same as the race, since in any given community there may be representatives of dif-

The Individual and the Race.

ferent races, Mediterranean, Scandinavian, Semitic and so forth, the individuals of which may or may not intermarry. Shall we provisionally agree to regard the community or the population as the sum or aggregate of the constituent individuals, say in Glasgow, in England, or in the British Isles as the case may be? And shall we agree to apply the word "race," rather loosely, to such a community? In this sense, the race is used antithetically to the individual—in either case, as it actually is under both nature and nurture. But can a race have *a* constitution, or *a* character, or *a* nature. When we speak of the character of a race or community, what exactly do we mean? Suppose, for example, that we make some general and comprehensive statement, saying that the race is improving or is deteriorating. We do not mean that every individual person in the community is at a higher or lower level of physical or mental excellence than his parents, grandparents, &c. We mean that the net result of all the changes of level is either in an upward or a downward direction. But how can we ascertain this? The only way to ascertain it with any approach to exactness is by the application of the method of statistics. No doubt we commonly make statements with regard to the improvement or the deterioration of the race on the basis of general impressions, the result of more or less experience gained by dealing with some special class of facts. We have probably not collected accurate statistics, and very likely we should not know how to deal with them if we had. None the less, just in so far as we do make general statements founded on the data afforded by observation, we adopt the procedure which the methods of statistics seek to render more precise and accurate.

Now the trouble is that we have in any given community a number of individuals, standing at different levels of excellence in respect of different characters, physical, moral, and intellectual. To simplify the problem before us let us select some one character, say, some physical character such as stature. How can we deal with that? Select some definite community or "population" which we judge to be typical. Take, for example, that given by Mr. R. H. Lock in his work on "Variation, Heredity, and Evolution." The selected

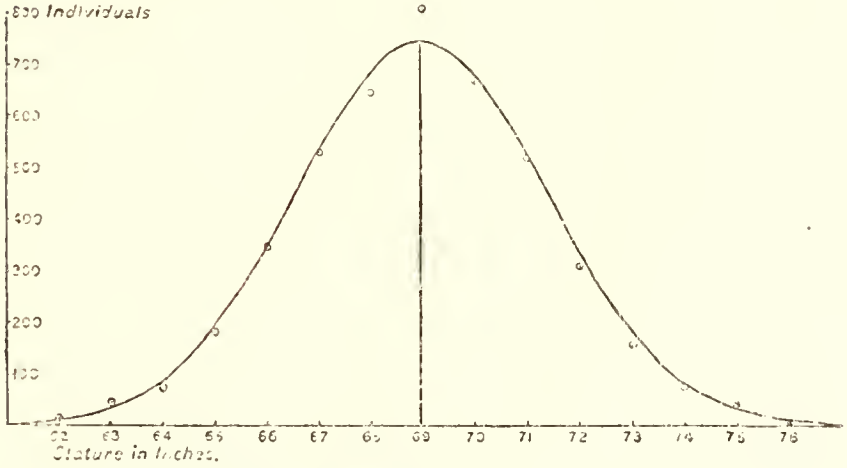


FIG. 1.—Variation in Stature: from "Variation, Heredity and Evolution" (John Murray), by permission.

population is here that of 4,426 members of Cambridge University of British extraction. Measurements by the Cambridge Anthropometric Society were made to the nearest inch of stature. The accompanying diagram from Mr. Lock's work (John Murray) shows the results. The height in inches is given on the base-line, while the number of individuals of any given height is shown by the length of the perpendicular from the base-line

to the point above it. The firm line is the "normal curve of probability," which most closely approximates to the recorded observations. It will be seen how nearly most of the observed numbers fall on the normal curve. The one which departs most widely is that which gives the number of individuals 5 ft. 9 in. in height, which is the average stature of the community selected.

Gauging Racial Characteristics.

Let us next assume that similar observations are recorded for other physical characters which can be accurately measured, and for mental characters which can only be estimated. Let us also assume that the net results of all these observations could be summarily recorded

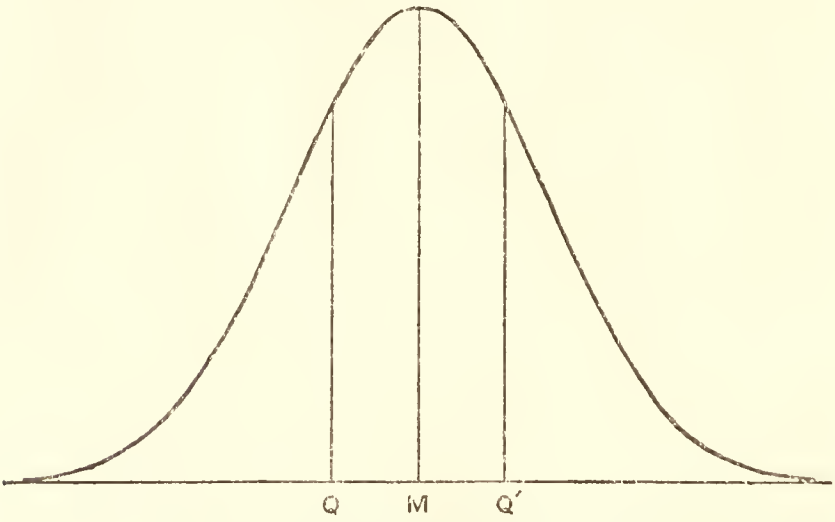


FIG. 2.—Normal Curve: from "Variation, Heredity and Evolation" (John Murray), by permission.

in one diagram. And let us further assume that we may take a normal curve of probability as standing for a generalisation that seems to be justified by its accordance with the results of actual observation in certain

typical cases. Suppose that the figure below represents such a curve. On either side of the central vertical line are two lines marked Q and Q′, indicating the "quartile" limits. Each of these lines occupies a position such that it divides the total area of the half-curve to right and left of the central median line into *two equal areas*. But these areas represent numbers of the individuals in the population comprised within their boundaries. The curve thus treated indicates, then, that the members of the community between the quartile limits form one-half of the total community; while to the left of Q there is one-quarter of the community, and to the right of Q′ one-quarter of the community. In this way the whole community may be divided into three cohorts: A the super-mediocrities, B the mediocrities, and C the sub-mediocrities. A will comprise one-quarter; B one-half; and C one-quarter of the whole population.

"The Normal Curve of Probability."

A few words may here be added with regard to the probability curve. First it must be clearly grasped that we are assuming that such a curve expreses an "ideal construction" based on definite principles. It then has to be determined how far observed facts accord with the theoretical curve. In the case of the stature of Cambridge undergraduates the accordance is fairly good. But in many cases we should find marked discrepancies between fact and theory. In what has just been said with regard to the three cohorts what is to be understood therefore is this: that *if* the distribution were in accordance with the normal curve, *then* there would be our three cohorts with the distribution above indicated. If, on the other hand, the number of individuals in the C-cohort is greater than that in the A-cohort—i.e., if there are in England

to-day many more sub-mediocrities than super-mediocrities—*then* there is some cause of this observed departure from the normal curve. And if we can find out what it is, we can seek to counteract it. The normal curve is thus of use in locating just where the departure from the normal lies, so that we may deal with it.

The Rule of Cause and Effect.

For we commonly assume that every event which we observe has some cause: we assume strict uniformity in the correlation of cause and effect; and we find that these assumptions are justified by appeal to what is given in experience of fact. In the tossing of a coin, for example, there is, we believe, something in the conditions which rigidly determines whether it shall fall head or tail. But what these conditions are in each several case we are unable to ascertain. It is found, however, that a general rule holds good when we can record a great number of cases, so that there is a reasonable expectation of the frequency of occurrence of the sequence head-tail, head-head, tail-tail and so on. It is this rule that the normal curve of probability expresses in graphic form. It does not imply the absence of strictly uniform laws of causation; nay, rather it implies their presence. But it does also imply our ignorance of the exact combination of conditioning circumstances in any given particular case. And what it does afford is a reasonable ground of expectation in the light of which our ignorance is discounted. So far, then, as the statistical treatment of physical and mental characters appears to afford a basis of reliable expectation, this means that uniform laws of causation obtain in human life, and that, in the midst of bewildering complexity, we may confidently expect certain definite results not in each

particular case, but as a general rule applying to a large number of cases.

Enough has now been said with regard to statistical treatment to justify the conception of three cohorts; the mediocrities forming approximately one-half of the community, with super-mediocrities on the one hand and sub-mediocrities on the other hand, each of these forming, in the absence of disturbing conditions, one-quarter of the community. It takes us a step forward towards understanding what we may mean by the character or the nature of a community. The whole race includes all three cohorts, A, B, and C. But we may group the individuals on a definite principle into our central mediocrities, with supers above them and subs below them.

So far, however, we have only grouped the individuals in a given generation. We have now to consider a series of successive generations; for what we want to get at is the outcome of the changes, if any, which occur, and, if possible, the causes of these changes regarded as effects. If we can do this it may afford a basis for practical effort.

Let us enumerate what appear to be the chief logical possibilities:—

(1) There may be an at present inexplicable tendency in human nature:

(*a*) Either for the C's to pass upwards towards the B class, the B's towards the A class, and the A's towards yet higher types; in which case there would be in human nature an inherent tendency to improvement.

(*b*) Or for the A's to pass downwards towards the B class, and so on; in which case there would be an inherent tendency to degeneration.

(2) (*a*) The super-mediocrities may be more prolific than the sub-mediocrities, in which case there would be improvement.

(*b*) Or the sub-mediocrities may be more prolific than the super-mediocrities, in which case there would be degneration.

Otherwise stated, those to the left or to the right of the median line may have the greater number of offspring, and therefore give a preponderant number of individuals in the next generation.

(3) The conditions of nurture may be such as either (*a*) to raise or (*b*) to lower the level of realisation of all that is given in inherited nature, whereby the actually existing race, under both nature and nurture combined, would show (*a*) improvement or (*b*) deterioration.

Inherited Capacity and Acquired Ability.

This introduces the distinction between inherited capacity, under nature, and acquired ability, under nurture. It is clear that, if we start with our three cohorts classified under A, B, and C, in virtue of inherited capacity, the individuals may have to be reclassified in virtue of their acquired ability under nurture. Thus the cohort B by nature may yield under nurture Ba's, Bb's or Bc's. The combined classification gives the status of the individuals as we see them in daily life.

(4) The favourable or unfavourable results under (3) may be transmitted to the next generation, which will start at a higher or a lower level of "nature," or they may not. In the former case the effects of nurture would be cumulative in a series of generations. In the latter case "sufficient unto each generation is the nurture thereof."

(5) There may be from some cause or causes elimina-

tion of Aa's in larger proportion than Cc's, or of Cc's than of Aa's. In other words, natural selection may be a factor in human progress. In either case, the balance of numbers as between the super-mediocrities and the sub-mediocrities (or between those to right and left of the median line) will be altered, and the community as a whole would be improved or the reverse.

We shall proceed to consider these possibilities severally. But before doing so, it may be well to note that if the tendency to improvement or the reverse, under (1), were uniform in all members of the community, there would be no change in the form of the curve on this account. The median line would just shift to a higher or a lower value, and the whole curve would shift with it. But if, under (2), the relative numbers of A's and C's change from one generation to the next, the curve will tend to alter in form and to become asymmetrical. The balance on either side of the median line will be upset by the increased or diminished numbers on this hand or on that. There will be a skew-curve; and wherever we find this lack of symmetry we are invited to ascertain what is the cause of this skew effect. That the curve for stature is approximately symmetrical suggests, therefore, that there is no specific cause which tends to alter the balance of stature on this side or on that. But suppose that those who entered for measurement had to pass upright through a doorway the top of which was 5 ft. 11 in. from the floor. It is clear that those whose stature exceeded this would be excluded. The effect on the curve in such an extreme case would be obvious. And if we did not know what the circumstances were, we should be led to inquire to what cause the asymmetry of the

curve was due. In the case of natural selection, under (5), the individuals eliminated would be, in an analogous manner, excluded. But the skewness of the curve for those who survived would be presumptive evidence that some cause was, as we say, operative, or more accurately, that the asymmetry was correlated with some assignable conditions which require investigation. It would, however, take us too far afield to pursue this matter any farther.

CHAPTER II.

THE STOCK AND THE RACE.

Although the existence of an inherent tendency to improvement or degeneration has been placed first in our provisional list of logical possibilities, it is very difficult to obtain definite evidence which unmistakably leads to the conclusion that it does exist, in this direction or in that, as something independent of hereditary correlation and the influence of environing circumstances. From the biological point of view the question is related to that of the origin of variations. It may be that favourable or unfavourable variations arise from the nature of the organism as an expression of what M. Bergson calls the impetus of life, which for him is the source of all organisation, and that we must just accept them as thus given. There may be in human life an inherent tendency to reach an optimum level of stature, strength, and health, of moral, æsthetic, and intellectual development. But it would seem that such a tendency can only be accepted as inherent in man's given constitution after a consideration of other factors of change, and after it has been shown that these factors do not suffice for the interpretation of all the observable facts. To these other factors we may now turn.

We seek to analyse the problem before us; and to that end we must distinguish the several co-operating factors so as to see what would happen if other factors were excluded. Now one of the factors is undoubtedly the occurrence of variations, in some way arising in favour-

The Occurrence of Variations.

able or unfavourable directions. Let us, however, at present assume that on the average these variations, upward and downward, just balance. It is clear, then, that on this assumption, if the numbers in two generations, parents and offspring, remain the same, there will neither be improvement nor the reverse. We are now to suppose that the numbers do not remain constant, and to see what the result will be.

Revert to the division of the community into three cohorts and assume that, to begin with, the distribution is in accordance with the normal curve, with one-quarter of the population super-mediocrities, one-half mediocrities, and one-quarter sub-mediocrities. By this, of course, one does not mean social distinctions. By supers are meant those who are distinctly above the average in physical vigour and intelligence; by subs, those who are below the level of mediocrity in these respects; in each case no matter what their social position may be. No doubt physical vigour and intelligence need not go together; but we must simplify the problem, and may therefore provisionally assume that they do. In any case the intellectual status has important bearing on what seems actually to take place. For here we are up against matters of fact. Do the supers and the subs have on the average the same number of children? If we look at the question from the point of view of physical characters only, there may well be some advantage in fertility on the side of super-mediocrities, for they (supposing that they intermarry within their cohort) are the stronger and healthier. But if, as we have provisionally agreed to do, we take into consideration mental characters also, then we must bear in mind the fact that the supers have a keen sense of responsibility, do not marry until they can well afford to bring

up a family in comfort and see their way to provide for their children. On the other hand, the subs, among whom are included the feeble-minded, have less self-restraint, marry young, and often beget many children. They trust in the State or Providence to provide for their children, having but little providence in their natural make-up. Is it not probable—is it not in accordance with experience—that the subs beget more children than the supers? But we need more statistics. Those which we have are partly based on social class-distinctions. It has been said that in the upper classes the average number of children is under 2 (1·6) in the family; while among the more or less feeble-minded there are over 6 (6·4). Since we here seek only to illustrate the results of different rates of increase in the three cohorts, let us assume that there are, in Class A, 2 in a family; in Class B, 4; and in Class C, 6, on the average. What will be the effect on the community in, say, five generations, supposing that they always intermarry within their own cohort, and supposing that all survive to bring up a family?

The Three Cohorts and the Family.

	Super.	Med.	Sub.	Per cent. of sub.
First generation ...	2	4	2	25
Second ,, ...	2	8	6	
Third ,, ...	2	16	18	
Fourth ,, ...	2	32	54	
Fifth ,, ...	2	64	162	71

Taking these figures as they stand, we see that the supers have not increased in number, while the mediocrities have increased 16-fold, and the subs 80-fold! It is clear that the average statistical individual is pulled down in level owing to the preponderant number of sub-mediocrities. This may be illustrated thus. Suppose

we assign the purely arbitrary mark 10 to the average intellectual status of the mediocrities, the mark 12 to the supers, and 8 to the subs. Then the average status of the whole community will be 10. But in the fifth generation we have:—

2	at	12	=	24
64	,,	10	=	640
162	,,	8	=	1,296
228	,,	x	=	1,960

The value of the average status of the whole community will be:—

$$x = \frac{1960}{228} = 8{\cdot}6$$

Hence the average intellectual status of the members of the community will have fallen from 10 to 8·6, a reduction of 14 per cent.

Now it must be remembered that these figures are not given as representing the actual facts. They represent what would be the state of affairs under certain assumptions. And they give what we may hope is an exaggerated view of that which actually obtains. The subs are presumably not increasing in numbers so rapidly. Although there may be six in a family, on the average, not all these live to marry and have six children. The mortality in their cohort is probably high; they are constitutionally weak, and therefore succumb to disease and the strain of life. Some diseases, bodily and mental, occur earlier and in a more intense form in the offspring than in their parents, so that the offspring may thus be precluded from themselves becoming parents. Furthermore, it is

Counteracting Influences.

not improbable that *effective* increase (taking into consideration not only the numbers born, but those who survive to have healthy children) is greatest among the mediocrities. There is some evidence in the animal world which at any rate suggests that there is a definite correlation of fertility with the typical characters of the species. That is to say, in stable races, typical persons, those nearest in character to the statistical individual as representing the average of the community, are likely (other things equal) to be more fertile than those which depart in any marked degree from the normal. One must grasp how complex the problem really is. But there is enough basis in fact to give cause for grave anxiety. It can hardly be questioned that the subs have more children than the supers. And it is probably true that the level of the inborn characters of the race as a whole is not so high as it was some generations ago. It is at any rate believed by many competent people that there is a really existent downward tendency. For if those below the level of mediocrity marry earlier and have more children than those above that level, then we have here a factor in degeneration. And here we have a cardinal point in that doctrine of eugenics which Francis Galton preached, and which he hoped might gradually be incorporated in the national conscience. In his own words eugenics

The Meaning of Eugenics.

"is the study of agencies under social control that may improve or impair the [inborn] racial qualities of future generations, either physically or mentally." All legitimate and decent means should be adopted, largely through the pressure of social opinion, backed up by wise and timely legislation, which may lead to an increase in the births in that section of the community which con-

tains persons above the level of mediocrity, and a relative decrease in the births within the cohort of sub-mediocrities.

It does not lie within my province to suggest practical remedies. Late marriages among some of the super-mediocrities, men in the Civil Service and others, are partly due to the scale of remuneration in the early stages of their career. But the ways in which an increase of births at this end of the scale can be secured in the national interest are full of difficulty. At the other end of the scale something can be done, and is being done, by legislative measures to check the promiscuous increase of the palpably feeble-minded. As defined by the College of Physicians, a feeble-minded person is "one who is capable of earning his living under favourable circumstances, but is incapable, from mental defect existing from birth or from an early age, of competing on equal terms with his normal fellows, or of managing himself or his affairs with ordinary prudence." All such persons fall within the cohort of sub-mediocrities. But it is on the more extreme cases that most people might feel justified in advocating legislative constraint even if it interferes in some degree with the liberty of the subject. The question thus becomes an ethical one, and the practical answer that is given depends on the ethical ideals that are accepted. It is clear that what has been said above depends on the assumption that there is hereditary correlation of the characters, mental and physical, of parents and offspring. What measure of correlation may be accepted on statistical evidence we shall have to consider hereafter.

The Question One of Ethics.

We may now pass to the aspect of our problem which

was indicated under (3) at the close of the summary given above. The question here is: What is the relation of the statistical individual by nature (on the assumption that all his inherited capacity, mental and physical, were realised under optimum conditions) to what he actually is under nurture. In other words, What is the relation of the actualities of racial development to the hereditary possibilities? It goes without saying that few, if any, of us *are* all that we *might be* under the most favourable circumstances. And it is patent that some fortunate folk are nearer what they might be than others. Looked at from the intellectual side, who has not met men among the working classes whose mental capacity we judge to be well above the average but who, through defective education, have not been able to make the best of their native power? Who has not seen hundreds of office-bound men and women, whose health deteriorates under the strain or the monotony of their work, through no hereditary defect—who would not thus suffer in health and vigour were their lot less severe and their life less cramped? Such are, some would say, the disastrous accompaniments of a vicious social system. Such are, others will urge, the penalties which the community has to pay in return for the privileges of a highly-evolved civilisation. Any given child is the heir to a nature in virtue of which he may attain to a level of development, physical and mental, the limits of which we could, with adequate knowledge, assign. It varies, of course, with different children. But the variations could, if science were equal to the task, be treated statistically. If this were done we should reach the conception of the statistical individual, as he might be under optimum conditions, and should

The Tyranny of Circumstance.

be in a position to compare him with the statistical individual as he is under actual conditions. The task is at present beyond us. But in the absence of accurate statistics we may be pretty confident that the race as it is does not attain to the level of the race as it might be.

It appears, therefore, that when we speak of the improvement or the deterioration of the race we may mean one of two things. We may mean (*a*) the race as represented by the statistical individual in his actual state of development under existing conditions of nurture, or we may mean (*b*) the race as gauged by its hereditary potentialities—as it would be under the best possible conditions of nurture. We may now reserve the word "race" for the former, and use the word "stock" for the latter. On these terms *deterioration* of the race, in the sense of failure, under adverse circumstances, to realise to the full its inherited possibilities, does not necessarily imply *degeneration* of the stock.

The Race and the Stock.

In the case of wild animals, under natural conditions, the level of attainment in the race probably does not fall far short of the hereditary possibilities of the stock. In their active vigorous life, subject to a keen struggle for existence under which weaklings are eliminated, they actually are pretty nearly all that they can be. In the case of human folk, under social conditions, however, this is not so, and how the conditions can be rendered better is an important practical question. But the problem it presents is *not* the eugenic problem. That problem is one with regard to the hereditary nature; this problem concerns the effects of nurture. The eugenic problem is how to get the best human stock; this problem (that of environment and its influence) is

how to make the best of the existing stock by fostering the development of the race. Only on the assumption that gain or loss in one generation is inherited in the next does this problem pass upwards into that of eugenics.

The conception of the relation of the organism to its environment is sufficiently familiar. Given a normal embryo, and given also a favouring environment, we can state what the course of development will be, and we can do so because we have submitted the matter to observation and research. In any case the statement is the outcome of actual experience. The grain, in the parable of the sower, yields some thirty-fold, some sixty, and some a hundred. Given the best conditions we can count on the hundred-fold yield. Of such yield there is in the seed the latent potentiality; but this is dependent on structure and functional activity actually present in the seed. In virtue of its vitality it is a going concern, and we can foretell its future if we know the influences to which it will be subjected. If then, we say that the human infant has certain hereditary potentialities or possibilities of development, we mean that it inherits such structure and functional activity as will under favourable circumstances give certain assignable results. The trouble is that in the case of any given child we cannot accurately gauge its hereditary dower, though the laws of hereditary correlation furnish statistical probabilities. Nor can we say exactly how much of its inherited capital is realised in the course of life, though here again we can make rough estimates. In any case it can scarcely be doubted that there are wide divergences on this side and on that from the mean of actual development, and that there is a considerable interval between the mean of

hereditary potentiality in the human stock and that of realised physical and mental attainment in the human race. One of our social aims is to lessen this interval by improving the conditions of nurture. What is the demand for equal opportunities for all, but a claim that inherited capacity shall be realised, so far as is possible, in every individual throughout the community?

Deterioration and Degeneration.

A distinction has been drawn between deterioration in the race and degeneration of the stock. Revert to the parable of the sower. Suppose the grain fall on stony ground, and the scanty yield of seed again fall on stony ground, this being continued for several generations. Then we should say that the seed gave deteriorated crops, indicating thereby that there is a large measure of short-coming from the normal level of yield. This deterioration is the result of unsatisfactory conditions of nurture and need not betoken any lack of hereditary potentiality. There need not be any degeneration. The seed produced by the third or fourth generation may produce, in a favourable soil and under the best conditions, a hundred-fold yield, or it may not. Whether it does or does not is a question to be determined by observation. This question of fact is of importance for scientific interpretation, and has an important bearing on practical problems. The question is: Does deterioration in the race lead to degeneration of the stock? Or, looking at it from the other side: Does improvement of the race through better nurture (including the results of education) raise the level of inherited nature in the next generation? What we should no doubt like to find is that deterioration does not lead to degeneration, but that improvement in nurture does raise the level of inherited nature. But

it is questionable whether we are likely to find the world thus ordered in accordance with our likings. In any case we should realise what the passage from deterioration to degeneration, if it obtains, comes to. It is a lowering of the hereditary possibilities. It is not only a shortcoming in the level of physical and mental attainment; it is a depreciation of hereditary capital. It means not only that there is a failure in realising all that is bequeathed through heredity, but that there is a diminution of the racial bequest. It means not only that the actual physical and mental status is lower than it might be under bettered conditions, but that so high a status as heretofore is no longer possible, unless or until the lost ground has been reclaimed. Hereditary degeneration is a far more serious matter than deterioration due to adverse surrounding conditions.

We are thus led to a consideration of hereditary correlation which will next engage our attention.

CHAPTER III.

CORRELATION.

There are perhaps some of us who regard correlation as a blessed word, like Mesopotamia, which gives comfort in proportion to the halo of ignorance which surrounds it. A student is said to have defined it as "an impenetrable mystery, best exemplified by the fact that white blue-eyed tomcats are generally deaf." In this luminous definition there is at any rate an implied distinction between, on the one hand, a fact—which, if it be a fact, is presumably, as such, neither more nor less mysterious than any other fact—and, on the other hand, a sought-for explanation or interpretation of the fact, say, in physiological or other terms. Since no such explanation is forthcoming, the correlation is said to be an impenetrable mystery. Dealing, however, with the statement of fact it is somewhat indefinite. The expression "generally deaf" leads one to ask in what percentage of cases. This surely might be determined without trenching on the province of mystery. Take another case. It is commonly asserted that weakness of mind (intellectually) and feebleness of will (morally) in large measure go together. Here we have the assertion that the one is correlated with the other, with the rather vague qualification "in large measure." One seeks to know in what measure. It has been found that in certain penitentiary institutions the immoral in-

Facts and their Interpretation.

mates are intellectually defective as gauged by "Binet's tests." So far the fact of some correlation between feebleness of will and weakness of understanding seems, in such cases, to be established. But one needs further data to afford a measure of the correlation. I seek to help the reader to understand what is meant by giving expression to such a measure in exact numerical terms.

Correlation between Parents and Children.

Let us start with what I spoke of as a correlation between the characters, mental and physical, in parents and offspring. And let us select some one easily-measured physical character, say, stature. We have seen that the variation in stature, in the individuals of a given population, or selected community, may be expressed in a diagram (fig. 1, Ch. I) which accords fairly well with a normal curve of probability. The variations in stature are symmetrically grouped on either side of the most frequent value or *mode* which is on the median line of the diagram. Above each number expressing stature to the nearest inch, there is a class of individuals which we may call the 65 in., the 69 in., the 73 in. class, and so on. Now suppose all these individuals marry and become the fathers of sons. Then we could deal with the population of sons as we had dealt with their fathers. We may fairly assume that the curve for all the sons is closely similar to that for all the fathers, and has the same modal value. But suppose we took all the sons of *one* class of fathers, say, that which includes all those of 65 in. in stature. We might then find that all the sons of any given class of fathers were of just the same stature as their fathers, i.e., it might be found that "class of sons" exactly corresponded to "class of fathers," say in each case 65 in. If this were

so we should then say that there was perfect correlation in stature between fathers and sons.

The problem is, however, practically complicated by the fact that the sons have mothers as well as fathers. Means may be devised for making allowance for this fact if we seek to find the measure of correlation with the male parent only. Or we may translate woman-stature into man-stature by adding so much to her height. For our present illustrative purpose it will suffice to add 5 in. to the stature of the woman. On these terms a woman of 5 ft. 7 in. would be as tall for a woman as her husband of 6 ft. is tall for a man. Suppose then, a man of 5 ft. 10 in. marries a woman of 5 ft. 3 in. Add 5 in. to her stature. She is the equivalent of a man of 5 ft. 8 in. And since her husband is 5 ft. 10 in. we may put man and wife together into the 5 ft. 9 in. class, wedding them as what Galton called the mid-parent. We could deal on similar lines with a whole population of mid-parents. Then again, if the class of sons and daughters exactly corresponded to the class of their mid-parents, 67 in. to 67 in. and so on, there would be perfect correlation.

Mid-Parents.

It is a matter of common observation, however, that the sons and daughters in a family vary a good deal in stature. They do not all belong to what we have called the same class, with the same stature—of course, "translated stature" for the women. If the variations were plotted on a curve they would show—in dealing with all the sons and daughters born to all the members of one class of mid-parents—divergences from the mode or value of greatest frequency. None the less, if this mode in the children had the same value as the class-value of the parents, there would still be perfect cor-

relation between the one and the other. As a matter of fact statistics show that this is not the case. For illustrative purposes we must simplify the results which have been obtained. We may tabulate these slightly "cooked" results as under:—

Class of parents	65″	67″	69″	71″	73″
Mode of children	67″	68″	69″	70″	71″

From this table it is clear that for relatively short folk on the one hand, and for relatively tall folk on the other hand, the mode of the children has a value nearer to the mode of the whole population than the class-value of their parents. In other words, and less technically expressed, according to statistics dealing with large numbers, the children of short people are likely on the average to be rather taller than their parents, and the children of tall people are likely to be rather shorter than their parents. This is in accordance with the law of regression towards mediocrity. We may ask why this should be so, and why, if it be so as a general rule, there are marked exceptions in particular families; but the answers to these questions may be deferred for a little. We must first inquire how such facts may be conveniently expressed.

Regression towards Mediocrity.

In the accompanying diagram, Fig. 3, the figures already tabulated are embodied along the broken line. But first for the method of construction. Along the top horizontal side of the square the stature of fathers is given in ascending order from left to right; along the left-hand vertical side the stature of sons is given in ascending order read downwards. Now if there were perfect correlation, the stature of the fathers in each

class, and the modal stature of their sons would be the same; and this would be represented by the firm diagonal line passing through the circles. For example, 67 in. fathers expressed by the circle at that distance measured horizontally from left to right, would have 67 in. sons expressed by the same circle at that distance measured vertically from above downwards; and so in other cases. The diagonal line then expresses perfect correlation. But according to our tabulated results this will not express the facts in their approximate form. The 67 in. fathers have 68 in. sons. We must there-

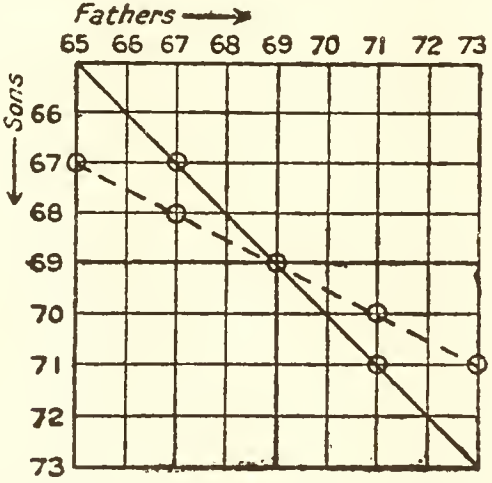


Fig. 3.—Correlation between the stature of fathers and sons.

fore place the circle representing both at the intersection of the 67 in. line of horizontal distance with the 68 in. line of vertical distance. Dealing with the whole series in similar fashion the correlation circles will fall on the broken line. And this line will give a measure of the correlation which obtains in our tabulated series. But how can we express its value?

Divide the whole square into four quarters and con-

sider the upper left-hand quarter. This too will be a square, and its four sides will be equal in length. Now what we want to do is to express in numerical terms the slope of the firm diagonal line and that of the broken line. Take first the diagonal line which stands, as we have seen, for perfect correlation. The base-line of our small square (from 69 on the left to the central circle of the figure) has a length of four divisions of the diagram. The vertical line of our smaller square (from 69 on the left to 65 above it) has also a length of four divisions. Now if we agree to place these numbers thus $\frac{\text{vertical length}}{\text{horizontal length}}$ they will be $\frac{4}{4} = \frac{1}{1} = 1$. We thus obtain 1 as what is called the "co-efficient" of perfect correlation. Deal next, in similar fashion, with the broken line. The horizontal length of the base line is again four divisions; but the length of the vertical line (from 69 to 67) is only two divisions. In accordance with our agreement then we shall have $\frac{2}{4} = \frac{1}{2} = .5$. The co-efficient of correlation is therefore in this case .5. The method of getting the slope is thus quite simple. We have only to measure the base line of the small square, and the vertical length to the starting-point of the sloping line and put the numbers we obtain in the form of a vulgar fraction, or (better) express it on the decimal system. That gives us, in the case before us, an accurate numerical expression of the measure of correlation based upon the results as tabulated for stature. The actual figure may not, as in this simplified statement, be exactly .5. For fathers and sons it may be rather less; for mid-parents and children rather more. But the actual value is sufficiently near to .5 to justify our simplified illustration of the principles involved.

Now apart from rendering more clearly what is

meant by giving to correlation a numerical value, the diagram serves to show what we are dealing with in all cases of correlation. We are dealing with two sets of variables such as can be plotted, the one along the horizontal and the other along the vertical of our square, and such as can thus be brought into relation at the points of intersection. We may thus compare either the same character, e.g., stature, in two groups of individuals, or two characters, say, stature and arm-spread, in the same group of individuals. In this way, with adequate data, we could correlate weakness of intellect and feebleness of will in penitentiary inmates.

All Correlation is between Two Sets of Variables.

Where mental characters are under consideration the difficulty is that we cannot *measure* "to the nearest inch" as we can in the case of physical characters. We can only *estimate* the rank in an ascending scale. This is what we attempt to do in an examination. We assign to the candidates relative positions, using marks as a help and guide. But we cannot measure intellectual stature as we measure physical stature. None the less we may at least hope that, notwithstanding errors of judgment, examination results do afford data of sufficient value to justify correlation.

Twenty-two students took among other subjects English and psychology. In the diagram Fig. 4 their rank in class is given in each subject. Where two students are bracketed as equal, e.g., 2 and 3 in psychology, they are assigned a rank of $2\frac{1}{2}$; where three students are equal, e.g., 8, 9 and 10, to each is assigned a rank of 9; where four are bracketed, e.g., 6, 7, 8, 9 in English, to each is given a rank of $7\frac{1}{2}$. It will be seen that the student who was top

in English was top also in psychology. The student who was bottom in psychology stood 20th in English. The student who was 13th in English was 11th in psychology, and so on. Although the circles are somewhat scattered, the diagram shows, on simple inspection, that their distribution is not merely haphazard. The slanting line gives the co-efficient of correlation as about ·72.

But how can we find out what is the slope of this

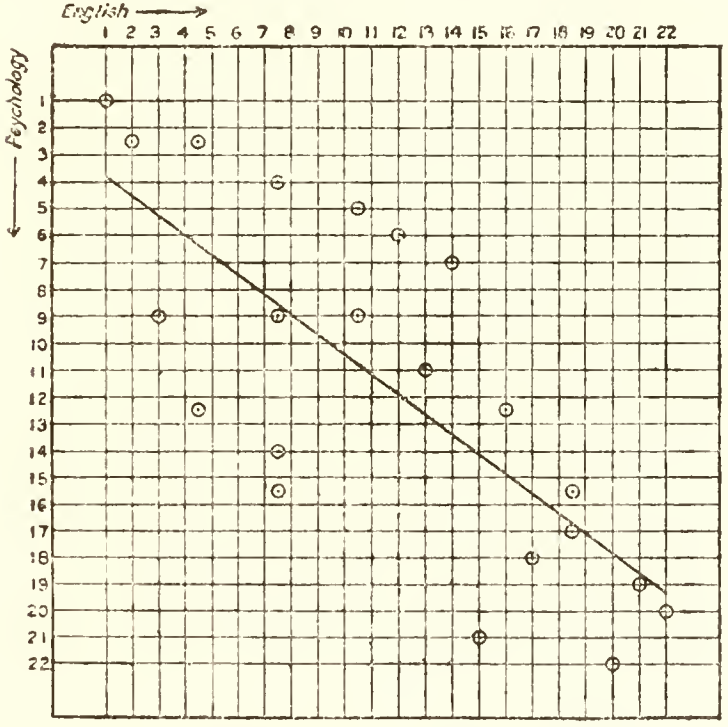


Fig. 4.—Correlation between two intellectual characters.

line? It is a matter of calculation. There is a longer and shorter method of dealing with the data so as to obtain the run of this line, and hence a value for the co-efficient. It must suffice to give the shorter method as developed by Professor Spearman (*Brit. Journ. of*

Psych., vol. ii, p. 89). The treatment is, however, rather technical. It may interest some readers. Those who do not care for figures and formulæ, and do not wish to know how the slope of the line is ascertained, may exercise their right to skip the next paragraph.

I take another example from the record of an examination. Eleven degree students (A to K) took English literature and history, with results as under:—

	Rank in history	Rank in English	Gains or losses in English	
A	8	6	2	0
B	4	7	0	3
C	$2\frac{1}{2}$	2	$\frac{1}{2}$	0
D	11	$10\frac{1}{2}$	$\frac{1}{2}$	0
E	9	5	4	0
F	$2\frac{1}{2}$	3	0	$\frac{1}{2}$
G	1	1	0	0
H	5	9	0	4
I	6	4	2	0
J	10	$10\frac{1}{2}$	0	$\frac{1}{2}$
K	7	8	0	1
			9	9

The third and fourth colums of figures give gains or losses of rank in English as compared with history. For example, A is 2 places higher in English, while B is 3 places lower. Now it has been calculated that the sum of the gains (or losses), M, is, on a basis of mere chance, $= \frac{N^2-1}{6}$, where N is the total number of persons. On this short method the co-efficient of correlation $R = 1 - \frac{\text{sum of gains}}{M}$. In the above case, therefore,

$$M = \frac{11^2-1}{6} = 20, \text{ and } R = 1 - \frac{9}{20} = \frac{11}{20} = .55.$$

But this method gives a value of R, which is lower than that obtained by the longer and more exact method. Professor Spearman therefore gives a table of conversion from which the value of *r* (the recognised co-efficient) equivalent to any given R obtained

by the short method, can be seen. In this case the value of r is, according to the table, ·76. Worked out by the longer method it is ·768. This value is high because English literature and history are allied subjects. If we had taken the correlation of rather diverse subjects, such as history and arithmetic, the value of r would be much lower—e.g., in a case before me, ·39.

My aim has been to show that hereditary correlation is only a particular case of the correlation of variables, and that by appropriate methods, not only physical characters, but mental characters also, may be statistically treated. To return now to hereditary correlation. Instead of dealing with parents and children it may often be more convenient to deal with brothers, or sisters, or brothers and sisters, as heirs to a common heritage from the same parents. The following values are taken from Professor Karl Pearson:—

Correlation between Brothers and Sisters.

	Brothers	Sisters	Brothers and sisters
Vivacity ...	·47	·43	·49
Popularity ...	·5	·47	·49
Conscientiousness	·59	·64	·63
Temper ...	·54	·49	·51
Ability ...	·46	·47	·44

A mean value he has given for a great number of physical characters is ·5171, and for mental characters ·5214. Now if further research serves to confirm this result that the measure of correlation for physical and mental characters is approximately the same, it is worthy of special note, and has, as we shall see, an important bearing on the question whether acquired characters are inherited.

It remains, in the present connection, to revert to the question why there should be the regression towards mediocrity to which allusion has already

been made. The answer comes through an extension of the methods of correlation. The child inherits not only from its parents, but through its parents (in some way) from grandparents and more remote ancestors. If this be so, it remains to correlate, say, stature in sons with stature in ancestors. Galton, on the basis of the statistical evidence he collected, suggested that half the hereditary dower comes from parents, one-quarter from grandparents, one-eighth from great-grandparents, and so on; or, in brief, half from parents and half through parents from ancestors. Now since the ancestors spread back into a wider section of the community, the ancestral dower will, in the majority of cases, be nearer the mode of the whole population; and there will be, as a general rule, where large numbers are considered, a regression towards this mode. But in particular families some character may run through several generations, and may be a salient character in this special line of the general stock. That line may be a line of selected variants in some given direction. In that case we may expect departure from the general rule which holds for large numbers within which particular cases are merged. But ancestral correlation may serve to account for this departure.

Ancestral Heredity.

In place of the figures quoted from Galton, Professor Karl Pearson gives ·6244 for correlation with parents, ·1988 for grandparents, and ·0630 for great-grandparents; or, in brief, about ·62 parental, and ·38 ancestral. Whatever may be the actual figures which are eventually accepted, there seems to be a law of ancestral heredity. As Dr. Yule expresses it: The mean character of the offspring can be calculated with more exactness, the more extensive our knowledge of the corresponding characters of the ancestry.

CHAPTER IV.

MENDELIAN INHERITANCE.

I tried in the last chapter to illustrate one line of treatment applicable to problems of heredity—the statistical discussion of the correlation disclosed when two sets of variants on either side of a mean value are methodically compared. In the cases which were considered it was tacitly assumed that the variations were continuous, i.e., that, given a sufficiently large number of data, in any set of variants, say in stature, measured not merely for convenience of treatment, to the nearest inch, but to some small fraction of an inch, the values would fall on, or near to, the continuous curve of probability. But it is clear that very exact measurements, very carefully treated, might disclose that there were very small steps or jumps —not a quite continuous slide—from any given value to the next on each side of it. All that we can say is that in some cases the variations are apparently and approximately continuous. When, however, we review the facts of plant-life, of animal-life, and of human life, we find many cases of discontinuous variation—that is of variants which show a distinct step or leap in some given direction. Such discontinuous variations have for long been known; when well-marked they have been spoken of as "sports." But Professor Bateson has brought an extensive body of evidence for their wide occurrence. Professor Hugo de Vries terms such steps *mutations*, and has urged that it is by mutations, and not by continuous fluctuations, that

Variation—Continuous and Discontinuous.

new species originate. "The current belief," he says, "assumes that species are slowly changed into new types. In contradistinction to this, the theory of mutation assumes that new species and varieties are produced from existing forms by sudden leaps." Professor J. A. Thomson thus describes what he terms the oldest known mutation, which will serve as an illustration. "A few years before the close of the sixteenth century (1590) Sprenger, an apothecary of Heidelberg, found in his garden a peculiar form of *Chelidonium majus* or greater celandine. It was marked by having its leaves cut into narrow lobes with almost linear tips, and by having the petals also cut up. This sharply defined new form suddenly appeared among the plants of *C. majus* which the apothecary had cultivated for many years. It was recognised by botanists as something quite new, and eventually it got the name *C. lanciniatum;* it was not to be found wild or anywhere except in the Heidelberg garden. But from the first this new cut-leaved celandine proved constant from seed." Such a sudden departure from the normal type is an example of discontinuous or step-wise variation.

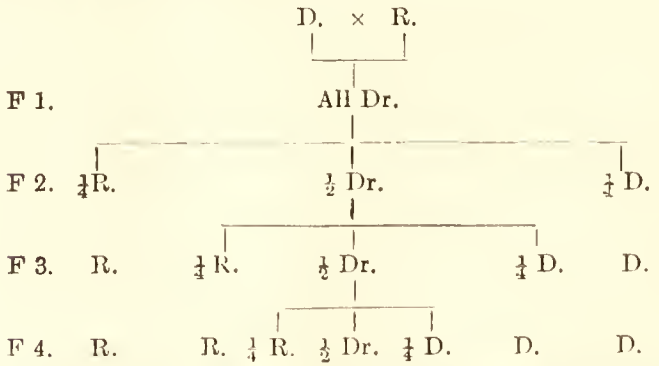
The Mendelian Theory.

In 1865 Gregor Mendel, Abbot of Brünn, the capital of Moravia, published a paper in which he described important experiments on hybrid varieties of plants. His results were long overlooked; but his paper was republished in 1901 and in recent years his methods of investigation have been revived and extended. The outcome is a large body of evidence in favour of what is termed Mendelian inheritance. One can only give certain salient features in relatively simple cases so as to illustrate some of the facts and the principles on which they are interpreted.

Of the edible pea there are varietal forms with differing characters; one such character is the length of the stem giving tall and dwarf varieties; another such character is the colour of the flower, purple or white. Let us deal first with the tall and dwarf varieties. When they are cross fertilised, the one with the other, hybrid plants are produced; but they are not intermediate in height between the parental forms; *they are all of the tall variety*. The seeds of these tall plants, fertilised within their community, are sown. Of the plants reared from them some are tall, others dwarf, *with no intermediate forms*. But the tall plants are more numerous in the statistical proportion of three to one. In dealing with large numbers it is found that 75 per cent. are tall and 25 per cent. are dwarf. This does not mean that they are all equally tall in the one variety or equally short in the other. In each there may be variation on either side of a mode. But the shortest talls have a height distinctly greater than that of the tallest dwarfs. There may be apparent fluctuation; but around *two* modes and not only one. Now since the offspring of crossed talls and dwarfs are all of them tall, the negative character of dwarfness (absence of tallness) is not in evidence in any of the members of the "first filial generation." Mendel termed the tallness *dominant*. But since, in the second filial generation one-quarter of the offspring of parents, all of which were tall, are dwarfs, this shows that the negative alternative is transmitted through tall parents. Mendel termed the dwarfness latent in the tall parents, but handed on to offspring, *recessive*. The tall habit in peas is dominant, the dwarf habit recessive. In the first filial generation all the plants show the dominant tall habit. In the second filial generation there are three dominant to one recessive.

Dominant and Recessive Types.

If now the dwarfs of this second generation are self-fertilised they produce seed from which spring nothing but dwarfs, and this will continue in subsequent generations, so long as no foreign pollen is introduced. They are *pure recessives*. But if the talls are self-fertilised, some of them produce seed from which spring nothing but tall plants; others produce seed from which spring both talls and dwarfs. From the tall plants of the former group nothing but tall plants are obtained in succeeding generations so long as they are self-fertilised. They are *pure dominants*. Those tall plants from which both tall and dwarf plants are derived are termed *impure dominants*. From these are derived seeds which turn out to be (*a*) one-quarter pure recessives (*b*) one-half impure dominants (all tall) and (*c*) one-quarter pure dominants (also tall); hence again three talls to one dwarf. From the impure dominants of this generation a like suite of (*a*) (*b*) and (*c*) are derived, and so on in succeeding generations. Symbolising pure recessives by R, pure dominants by D and impure dominants by Dr., we have in succeeding filial generations F 1, &c., the following scheme:—



If instead of dealing with the character tallness we record the facts for colour of flowers, purple is dominant

and its absence, white, is recessive. When purple and white are crossed all the offspring are purple. In the next generation derived from these purples, there are three purple to one white. This white is a pure recessive; one of the purples is a pure dominant; the other two are impure dominants, and so on in accordance with the scheme.

The Drama of Generation.

Let us now try to get a little behind the scenes in the drama of generation. Each plant produces germ-cells, ovules and pollen; an ovule is fertilised by a pollen-cell; from the resulting seed a new plant is formed. We speak of some character, such as the purple flower, as inherited—as though it were somehow passed on from parent to offspring. But there is no purple flower in the seed. There must, therefore, be something in the constitution of the seed which "determines" the character of the flower. Let us call this a *determinant*. But this determinant must be derived from the germ-cells of the one parent, or the other, or both. Now let us suppose that there is such a determinant for purple; and that any given germ-cell either bears this determinant or does not. Let us further suppose that half the number of germ-cells produced by any hybrid plant, in F 1, have the determinant for purple and half do not; and that they unite indiscriminately, one with another, in fertilisation. Then if we symbolise by P the presence of a purple determinant in the germ-cell, and by W its absence (giving white) the chance meetings are as under:—

Ovule	Pollen-cell		Seed	
P	P	gives	PP	pure dominant
P	W	,,	Pw	impure ,,
W	P	,,	Pw	impure ,,
W	W	,,	WW	pure recessive

We thus get, under this hypothesis, the same pro-

portions as are obtained experimentally; but we interpret the facts of observation in terms of the determining constitution of the germ-cells. Now suppose that the ovules of a hybrid plant of F 1, which produces P and W in equal numbers, are fertilised by the pollen from a pure white, W. The result on the hypothesis will be that there will be equal numbers of PW and WW unions, and therefore equal numbers of hybrid purples and pure whites. Mendel found that this expectation is endorsed by actual observation.

Consider now the combination of the results of crossing, say, dwarf whites and tall purples. Since tall and purple are both dominant and positive characters, all the offspring in F 1 will be tall plants with purple flowers. And if the hypothesis of determinants, as above outlined, holds good, it is simply a matter of calculation of the chances of union in fertilisation. If we symbolise for purple and white as before by P and W, for tall by T, and for dwarf or short by S, the numbers in the F 2 generation will be:—

1 PPTT; 2 PPTs; 2 PwTT; 4 PwTs = 9 tall-purple
2 PwSS; 1 PPSS = 3 short-purple
2 WWTs: 1 WWTT — 3 tall-white
1 WWSS = 1 short-white

Such proportions hold good approximately in experimental results. An interesting point is that among the F 2 generation, derived from the original crossing of tall-purples and short-whites, there are tall-whites and short-purples, i.e., *new* combinations of the characters. Thus new varieties of plants may be systematically reared and new strains that breed true produced. In this way, for example, a new variety of wheat combining good characters with immunity from "rust" has been reared and has proved to be of great economic value.

In the cases above cited dominance is complete. There may be shades of difference in purple colour, but broadly speaking it is either present or absent, and when it is strictly speaking complete, it matters not whether its determinant comes from one parent or the other or from both. Now in the colour of human eyes the trestle-like fibres of the iris bear particles which give it a blue colour. But in some cases there are in addition brown particles, for which the determinants must be derived from the germ-cells of one or other parent or both. We may regard, then, the brown colour as due to a positive determinant in the absence of which the eyes are blue. But we do not find this brown colour to be, as the only alternatives, either fully present or wholly absent. It may be present in small quantity gathered chiefly round the pupil, or in large amount, suffusing the whole iris and making it all brown. And between these extremes there are many gradations. None the less there is little question that presence of brown and its absence are a Mendelian pair. If pure blue eyes mate with pure blue eyes all the children are blue-eyed. But if blue eyes mate with brown eyes, one child in four may be blue-eyed. Still, since brown eyes vary from fully pigmented to slightly pigmented, there is apparently continuous variation which may be treated statistically in reference to one mode, notwithstanding the fact that brown and blue are discontinuous Mendelian characters. It is quite possible that all apparently continuous curves of variation may hereafter be shown to be due to the superposed combination of small discontinuous steps. And where dominance is not complete one may expect that, on the super side of the mode, determinants from both parents co-operate to

Colour of the Human Eye.

give a well-marked character, whereas determinants of varying strength, from one parent only, produce a less well-marked development of that character near the mode.

In all the higher animals and plants, and in man, the character of sex is normally a strictly alternative one; and with this character others—the so-called secondary sexual characters—are correlated. The character of sex, male or female, carries along with it certain other characters, partly through the instrumentality of certain internal secretions produced by the essential organs of sex. The biological relations are very complex and difficult to analyse; but light is being shed by current research on the problems involved and on the determining structures in the nucleus of the germ-cell, male and female. Such problems however lie beyond our present scope. It must suffice to note that some characters seem to be sex-limited, thus usually only males are colour-blind; they do not, however, transmit this defect to their sons, but may do so through their daughters (with normal colour-vision) to their grandsons—a fact which research on sex-determinants goes far to explain. On the other hand many characters are not sex-limited. They may appear in either sex and their determinants may be derived from the germ-cells of either parent or both. But it is probable that, notwithstanding complicating conditions, sex is fundamentally a Mendelian character.

Sex-limited Characters.

It remains to indicate briefly the bearing of Mendelian inheritance on eugenics. Certain forms of feeble-mindedness, perhaps all marked forms, seem to show a recessive Mendelian character. Hence, apparently normal parents, cousins for example, may have feeble-minded children.

It is in their line of stock, or, as we say, in the blood. Their family history will give evidence of a defective strain. Hence cousins, *within a defective strain*, should not marry. Now let us suppose that feeble-mindedness is a dwarfed condition of mental stature, analogous to the dwarf habit in peas. In the days before Mendelian research it might be said—as it may still be said by those who have not learnt the lessons it teaches—that after all the feeble-minded are few as compared with those of normal mental stature. Leave the matter to nature; and the intermarriage of these feeble folk with the more numerous normal folk will steadily lift the feeble up towards the level of mediocrity. They will in the long run approach more closely to the mental mode. But is it so with our pea-plants? Intercrossing does *not* get rid of the dwarf habit, nor raise it to a higher status. If it be there in the line of the stock, there it will remain, *unless you exclude the dwarfs from taking part in propagation*. Furthermore, apart from such exclusion, it is a matter of chance in pea-plants whether short meets with short, in fertilisation, or short with tall. But in human life there is a strong tendency for the dwarf-minded to mate (too often immorally) with their like, for reasons which are obvious. So that there is a bias towards the production of a feeble-minded strain. On these grounds, therefore, it seems justifiable, in the interest of the nation, that the intercrossing of the mentally and morally defective should be checked under legislative measures.

Feeble-mindedness a Mendelian Characteristic.

Fortunately, if there is a tendency for sub-mediocrities through congenital defect to mate together and produce a dwarf strain, there is also a tendency for marked supermediocrities to mate with their like and to give rise to

a line of eminently worthy folk. If the record of the notorious Juke family, so far as it has been traced, gives a list of paupers and criminals, stained with gross immorality and seemingly unbroken by a single eitizen of eonspieuous worth, the record of the deseendants of Jonathan Edwards is one of outstanding merit and excellenee in many branches of public service, seemingly unbroken by a single case in which a member of the family was convieted of crime. The philanthropists of the Edwards line have probably given far more to Soeiety than the heirs of Max Juke have taken from Society, though, for their keep in prison and poorhouse, this has been estimated at £250,000.

Max Juke and Jonathan Edwards.

If then in such and other such eases there seems to be a development of different "lines"—the dwarf-minded and the morally and intellectually tall—how does this square with the results of statistical treatment, which give an apparently eontinuous curve of variation on either side of a mode? Well, look at the matter thus. We have taken two "lines" within the stoek—a line of extreme super-mediocrity, and a line of extreme sub-mediocrity. But if there be, say, twenty other lines between these extremes, perhaps with more blending of charaeters among the medioerities, then the statistical curve will be the expression of the super-position and overlapping of the twenty-two several curves for the several lines. It seems then that detailed work on family "lines," is a means to the analysis into its several components of that which the method of statistics gives in condensed and summary form as a general net result.

CHAPTER V.

ACQUIRED AND EMERGENT CHARACTERS.

If we listen to a popular discussion on the inheritance of acquired characters in human life we can scarcely fail to notice how largely the arguments on each side are founded on conjectures. An able mathematician is shown to be the son of parents trained in the mathematical schools. Who can deny, exclaim some, that the special training which raised the parents to so high a level is transmitted to their gifted son? How else can we explain the fact that he is possessed of even higher ability in this particular sphere of mental work than that with which they started? And since such cases are numerous in so many departments of learning, have we not abundant evidence of the transmission of acquired aptitude? To which others reply: What proof do you offer of the assertion that the aptitude transmitted was acquired and not inborn? It is the combined innate faculty of two gifted parents, not the superadded results of training, that is inherited. And since this inborn mathematical power develops under the careful teaching of trained parents; since the child grows up in an intellectual atmosphere of the higher mathematics; no wonder he displays ability of this special kind, raised to its highest expression by assiduous care and guidance.

Are Acquired Qualities Hereditary?

And so on. A discussion of this kind, where conjectures gaily masquerade as evidence, is interminable. Neither party is likely to convince the other, since each is fully satisfied that the facts are on his side, and since neither has any intention of abandoning his cherished opinions.

I suppose, if we wish to look into the matter—and it is one that has practical issues—the first point to settle is what we are to understand by the word "acquired." In a sense every character may be said to be acquired, and must have been acquired either by the individual or by his ancestors at some stage of the evolutionary history. How else could it have come into being? And in this broad sense what is so acquired may unquestionably be transmitted. So too, in a sense, it may be said that no character can be acquired by the individual save on the basis of hereditary transmission. Can one acquire anything unless one inherits the power of so acquiring it? There must be inherited capacity of acquisition. In so broad a sense as this every acquired character implies transmitted capacity of acquiring it; and every transmitted character implies the acquisition of that which is so transmitted. Clearly, then, we must seek and find some narrower and more helpful definition, and adhere to it. But we must lay bare certain assumptions to prevent misunderstanding. We assume that heredity is a biological problem; and we assume that mental characters are correlated with physiological characters in the brain. Both assumptions may be questioned or denied; that is just why they must be clearly stated. Now if we provisionally accept these assumptions, we may turn to the biology of generation and development.

Correlation between Mental and Physiological Characters.

Each of us starts individual life as a fertilised ovum, which is analogous to the seed of the pea-plant. From this single cell, with a nucleus of double origin, and with determinants derived from both parents, come all the cells of which we are built up. If we call this the parent-cell, and all its progeny, in the developed organism, daughter-cells, the latter are divisible into two great classes. The one (A) contains those which go to the formation of the working tissues of the body. After the analogy of bees in a hive we may call them the worker-cells. The other (B) is a privileged class, supported and nourished by the workers—that which contains the reproductive cells. After the analogy of the hive we may call them the queen- and drone-cells. Following up the analogy, the workers take no direct share in the propagation of the race. In this sense they die childless. The drone-cells and queen-cells, by fertile union produce a new parental cell—the fertilised ovum. That is their special function. Now by pretty common agreement among biologists class A are called body-cells, and class B are called germ-cells.

Body-cells and Germ-cells.

And by pretty common agreement modifications of the body which result from what happens to the workers, through the surrounding conditions in which they are placed, are termed acquired characters. Of course every cell has characters hereditarily determined from within by determinants, and characters acquired by conditions external to it. The training of the workers in the brain of a mathematician, or of the workers in the muscles of an athlete, produces modifications of the tissues in which they are incorporated, and *these* modifications are called acquired characters. But since these workers,

so modified, are childless, these acquired characters cannot be transmitted *in cellular filiation*. The point, then, is that the workers are daughter-cells only; but the germ-cells are daughter-cells, and also, subject to the condition of fertile union, parent-cells. The workers, since they are not parent-cells, can take no direct share in hereditary transmission through cellular filiation.

All this is rather technical; but the problem itself is a technical one. Either leave it alone, or take the pains of grasping its true nature. In any case we have here a definite view as to what is to be meant by an acquired character, viz., one acquired by the working tissues of the body and not one which is gotten by the germ-cells through their surrounding conditions. If the germ-cells are poisoned or starved, their daughter-cells may suffer. But by definition the starved or poisoned condition of the germ-cell is not an acquired character; for acquired characters, as defined, are restricted to the worker-cells of the body. Now it may be said that by so defining "acquired characters" the question at issue is already prejudged. But that is not so. What is disposed of is the question whether any microscopically recognisable part of the substance of a germ-cell is derived from its sister body-cells. It seems that, as far as observation goes, this is not so; and in that sense a negative answer to this question is taken for granted. But (1) there may be minute particles—so minute as not to be microscopically recognisable—which, as Darwin suggested, are derived from the sister-workers and collected in the germ-cells; or (2) the sister-cells may exert some kind of influence upon the germ-cells which so mould the determinants as to lead to the production of characters like those

The Hypothesis of Transmission through Influence.

which were acquired. In either case the characters of the children would resemble those acquired by the parents. This, in either case, might be called *transmission through influence* as contrasted with transmission through cellular filiation. We have no right to say that this is impossible. But is it proven? Are there facts of heredity which necessitate some such hypothesis supplementary to transmission through cellular filiation?

So the question at issue after all comes back to one of fact. Are there facts of hereditary correlation which cannot be explained on the basis of cellular filiation? If so we must seek to explain them on some other basis. Now here, unfortunately, opinions differ. There are certainly some cases in animal life—not, as I think, very numerous—which are difficult to explain on the basis of cellular filiation (cf., Doncaster, "Heredity," pp. 90-97, *Camb. Manuals of Sci. and Lit.*). But they cannot be considered here. My own view is that they should, at present, be relegated to a "suspense account" pending further and more searching investigation. Apart from such cases, the main body of the evidence obtainable from animal and plant life appears (to me) to be such as to justify the view that transmission through influence is not necessary as a supplementary hypothesis.

As we have already seen. Professor Karl Pearson's researches show that the co-efficient of hereditary correlation is approximately the same for physical and mental characters. Now, for the most part the physical characters are such as place them outside the category of the acquired—or, let us say, such as to justify the inference that the factor of acquisition is quite subordinate to that of purely hereditary correlation. On the

other hand, the mental characters, including skill in act, are just those which are admittedly susceptible of improvement by training and education. One would therefore expect that, if what is acquired influences the determinants in the germ-cells, there would be a noteworthy difference in the co-efficient of correlation in the case of these mental characters from that which holds good for physical characters. But there is no such difference. And this, by the way, so far supports the view that mental characters are correlated with physical characters in the brain. Galton was firmly convinced that nature is far stronger than nurture. Further statistical evidence confirms this opinion, and renders it probable that the results of nurture are confined to the individual and are, in the great majority of cases, not transmitted.

Nature Stronger than Nurture.

I think one may say that current Mendelian treatment is wholly founded on the assumption that *all* the phenomena discussed are explicable on the basis of cellular-filiation; and the validity of this assumption seems to stand the test of appeal to observable facts.

There are, of course, some people who urge that conclusions reached by the study of peas or other plants, of rabbits and fowls or other animals, have no bearing on heredity in mankind. But, so far as they go, statistics seem to be against this view, and in favour of the view that the problem of heredity is a biological one. On this latter view the chief advantage of studying lower forms of life lies in the diminished complexity of the problem in these more simple forms. In any case, as I have said something on Mendel's peas, I will here add a few words on Johannsen's beans. Johannsen's aim was to get, by careful selection, " pure lines " of descent. Choosing, for example, the weight of bean-seeds on

which to conduct observations under controlled conditions, he found that their weight varied around a modal value in such manner as to give a normal curve. But the mode in the seeds of a self-fertilised individual plant was not necessarily the same as that for the race, even in a pure line of descent. He found that, when a pure line was established by selection, (1) a limit of average weight of the seeds was reached and could not be raised to a higher level by further selection; and (2) that, if the line was kept pure, there was little or no tendency to reversion towards mediocrity, i.e., the mediocrity of unselected beans. From very different data Professor Pearson has reached closely similar conclusions. Now, though the average weight of all the beans on one plant may differ but little from that of all the beans on another plant, within the same pure line, there is much difference between the weights of the several beans on the same plant, and even in the same pod. It looks as if there are differences in the acquired character of the supporting and nourishing tissue within which the germinal determinants are embedded. This may well be due to difference of nutrition in accordance with the position of the beans in a pod or of the pods on the plant stem. It looks as if *this* difference in size and weight is the result of nurture, and that the curve based on measurements thereof is an expression of that which is acquired through surrounding conditions, nutritive and other. It may be said that this is somewhat conjectural. But it seems a reasonable hypothesis on which to interpret the facts. If we provisionally accept it as a working hypothesis, then we have large beans and small beans on the same self-fertilised plant, and the difference in size and weight is acquired under nur-

An Example from Plant Life.

ture. Is this acquired difference inherited? Apparently not. Whether plants be raised from the smallest or the largest of these beans, the mean weight of the beans produced by the one or the other—the average yield of beans—is just the same. It seems then that acquired differences due to nurture are in this case not transmitted.

I give this example for what it is worth, and draw an analogy—also for what it is worth. Two sons of a mathematician, inheriting his capacity and also other inborn tendencies, diverge in life. Each has a modest competency. The one becomes a high wrangler, the other an amateur champion in billiards. The one, by special training, becomes a big mathematical bean; the other, so far as mathematics is concerned, is a small bean. If—I only say if—the analogy is valid, the son of the small bean may show as good inherited capacity for mathematics as the son of the big bean. I ask the reader whether the parable of the beans does not find illustration in human life. One must bear in mind that the complexity introduced by marriage often precludes the formation of a pure line through rigorous selection.

We may next ask why it is that acquired and congenital characters go together so closely as to give rise to the still prevalent popular opinion that the one is the cause of the other. Many years ago I suggested an answer to this question. My friends, Professor Mark Baldwin and Professor Osborn, offered a closely similar explanation; and we have never quarrelled over the quite unimportant matter of priority. I will put it my own way. An individual survives under the struggle for existence in virtue of what he is both by nature *and* by nurture. By nature he is heir to *variations* in the determinants, or their combination, favourable or un-

favourable to survival (+ V. or − V.); and by nurture he may acquire *modifications* which again are favourable or the reverse (+ M. or − M.). The favourable modifications are the result of effective training and education of that which is founded on inborn capacity. Now we may have—

+ V.	+ M.	that is, good natural capacity		well-trained
+ V.	− M.	,,	,,	ill-trained
− V.	+ M.	,, inferior	,,	well-trained
− V.	− M.	,,	,,	ill-trained

In the struggle for existence the probabilities are that − V − M will be eliminated, and that the preponderance of the surviving individuals will be + V. + M. These, as survivors, will mate and the + V. will be inherited. Thus, even supposing that neither + M nor − M, as such, is inherited, it none the less contributes to the survival, and therefore to the transmission, of germinal variations coincident in direction; for the + M supports, sustains, or nurses coincident + V, while the − M conspires to carry the − V towards elimination.

Indirect Influence of Nurture.

The biological race is won by the strong, both by nature and by nurture. And though the effects of nurture may be restricted to the individual, still in enabling that individual to win and to have offspring, it is indirectly, though not directly, raising the level of the stock under the conditions of natural selection.

There remains another and different question for brief consideration. We must go back to determinants in the germ. What exactly they are, who can at present say, though we know something about the nuclear structure in which they are embodied? One must put it vaguely and generally as something in the constitution of the germinal substance whose "prospective value"

is the production of the characters of the organism. Now granting that there are determinants in this sense by which the whole complex of characters is determined in serviceable harmony, are we restricted, under the guidance of analogies drawn from a comprehensive study of nature, to a sort of algebraical summation of these characters in fresh groupings? Or is there something more than a mere reshuffling of already existing characters—important, no doubt, as that is? Is what is gained or acquired (in the broader sense of the word) in the constitution of the germ a *new* determinant to *new* characters? Does the interplay of determinants give rise only to what G. H. Lewes called "resultant" effects, or are there effects which are what he called *emergent?* One must here ask what he meant by this distinction in terms.

Resultant and Emergent Properties.

If sulphur combines with carbon in suitable proportion there is a resultant weight of the compound produced. The weight of the carbon bi-sulphide is just the weight of the sulphur *plus* that of the carbon with which it unites. But other properties are wholly different—just as certain properties of water are quite different from those of hydrogen or of oxygen. These other new properties are not resultant only, but emergent; they give us something which is seemingly *not* present in the constituents which unite to form the compound, but *is* present in that which is formed by their union. Take another analogy. Each several note struck on the piano has its accoustical characters, its fundamental tone, its timbre, due to overtones, and so forth. A selected few of these are sounded together to form a chord. There seems to be an emergent character in what we then hear as a chord, something not merely

due to the summation of the constituent tones and overtones, something emergent. One knows not what to call it, save perhaps its "chordiness"! When Wagner introduced certain combinations of "wood and wind" the kind of effect produced on a "musical ear" seemed to carry with it an emergent character with a rich quality of harmony all its own. In some such way determinants may so combine as to give rise to new determinants by which emergent characters spring into being. Such emergent characters would be genuinely new departures in evolution. And since Mendelian treatment has taught us that such departures may be either present or absent in the offspring but are *not*, at any rate in some cases, watered down in an intermediate blend; in such cases an emergent character, once gained, need not be lost through intercrossing with those in whom it is absent. Thus, for example, may have arisen musical capacity as a distinctive and unquestionably hereditary character in mankind, emergent no doubt from the combining of determinants of a certain kind connected with our sense of hearing. Thus too may have arisen certain types of so-called genius.

Apart from such occurrence of emergent characters, it is difficult to account for evolutionary progress, and the origin of what seem to be new departures; or, let us say, so as to be on the safe side, certain features of evolutionary progress, where something new seems to come upon the scene, are thus more readily explained. One need hardly add that this explanation is fully in line with M. Bergson's doctrine of Creative Evolution, though it need not imply the acceptance of the fundamental tenets of his philosophy.

CHAPTER VI.

SELECTION AND SEGREGATION.

I suggested in the first chapter that, in so complex a problem as that under consideration, it would be helpful to distinguish severally, and to treat separately, certain logical possibilities. The first was that, apart from other factors of change, there may be an inherent tendency either in the direction of improvement or the reverse. Taking our three cohorts, A, B, and C, we may have:—

(1) A B C with inherent tendency to improvement preponderant

(2) A B C with inherent tendency to degeneration preponderant

(3) A B C with balance of inherent tendencies.

We can go now, tentatively, a step farther. If, as I suggested at the close of the last chapter there be emergent characters, due to combining union of determinants, and if we could be sure (which we cannot) that they are always in the direction of progress, then there would be an inherent tendency to improvement. In any case such emergent new departures in this direction, if they exist, would serve to provide for a higher level of A-characters in offspring than in their progenitors, and thus, through their transmission, for upward progress in the evolution of the stock.

Secondly, assuming that there is no inherent tendency in either direction, or that tendencies are balanced (under 3) a different rate of increase in numbers within

our three cohorts may be a factor in degeneration or improvement in the average status of the stock as a whole. Thus we may have in succeeding generations (parents above, offspring below):—

(4)	A	B	C	
	3A	2B	1C	with improvement in average status
(5)	A	B	C	
	1A	2B	3C	with degeneration in average status.

We have seen that there is some evidence to show that the alternative numbered (5) actually obtains and gives rise to problems with which eugenics must deal, either by fostering increase in super-mediocrities or by checking the increase of sub-mediocrities, or both.

Next, assuming that some given individual, say X, inherits a capacity of reaching a certain level, say X*a*, under the best conditions of nurture, other such individuals, under less favourable conditions, may (and certainly do) fail to realise all that is within their capacity by inheritance. Thus we may have (and do have) under different environing circumstances:—

(6) X_a X_b X_c at different levels of nurture and education.

Nature cannot be Improved upon.

Here it must be noted that, on this count alone, there is no provision for raising X*a* *above* the level of inborn capacity. He simply *does* realise all that he *can* realise of his inherited bequest. More than this he cannot realise. The very best is made of nature through nurture; there is, however, no improvement in nature. But here the further question arose, whether X may not acquire in the course of his individual life certain characters which are "transmitted by influence" to the germinal determinants. Suppose the individuals above symbolised by X to be modal mediocrities in cohort B; and suppose the acquired

effects of nurture to be thus transmitted. Then we have in succeeding generations:—

(7) Ba Bb Bc
A B C by transmission of acquired excellence or defect.

This seeks to express the fact (if it be a fact) that, by transmission of acquired excellence or defect, Ba, raised to the optimum level by nurture, has a son who is no longer a B but an A by nature, while Bc has a son who is only a C by inheritance. Apart, however, from the cases which, as I have suggested, should be placed on a suspense account, it is questionable whether what is expressed in (7) is in accordance with the facts so far as they are at present known. Still the expression must stand as a logical possibility.

Unequal Chances of Survival.

There is, however, another factor which is undoubtedly in some cases of great importance. We have tacitly assumed under (4) and (5) that all the offspring of A's, B's, and C's survive, or at any rate that there is an even chance of their survival. But we are now to suppose that the chances of survival are not equal. For some reason the A's may be worsted in the struggle for existence and may be eliminated; or for some reason the C's may fail to get what is necessary for the continuance of their life, or may succumb to adverse circumstances and die unmated. If we place those which are thus eliminated in brackets we have as the leading cases:—

(8) (A) B C leading to degeneration
(9) A B (C) ,, improvement.

In human life under normal circumstances the conditions of (8) will seldom obtain. But under abnormal circumstances, such as those of a great war, many of

our best may be chosen for, or may choose for themselves, places in the forefront of danger, and these stand a greater chance of being killed. Has there not during the last four years been elimination of some of the best of our youthful manhood? Of course, among those who have been passed for active service, there are also many who have proved unable to stand the strain, and some of these have been eliminated (under (9)) as relatively sub-mediocrities in vigour and stamina. Turning to animal life, there can be no question that many splendidly, if somewhat extravagantly, developed reptiles and mammals have been wholly eliminated, as species, when, through climatal or other changes, there was shortage of food supply, and when those which needed much were ousted by those who could sustain life on far less; while the elimination of sub-mediocrities in the struggle for existence is, of course, that which leads to the "survival of the fittest" under natural selection.

The True Meaning of Natural Selection.

It is sometimes contended that a theory of natural selection which was good enough for the latter half of the nineteenth century must be rejected by those who appreciate the outcome of research in the twentieth. But is this so? No doubt if natural selection be so defined as to be restricted to that which conduces to the survival of the more fit by the accumulation of many and diverse minute, almost insensible, and so-called fortuitous variations in favourable directions, through the elimination of those in which such variations are absent—then natural selection, as thus defined, may not be so important a factor in evolution as Darwin and his immediate successors supposed. The difficulty they had to face was to explain how what one

may call an harmonious chord of favourable variations, combining very many details each and all essential to the effective working of the whole so as to meet the more complex requirements of life, could have so apparently chancy an origin. But this is a question of the *origin* of variations, not of their *survival* and transmission. On this head we have fuller, but still imperfect, knowledge. There may be natural chords as emergent characters; the functional unity of the organism in subtle natural harmony receives more and more emphasis with the progress of physiology; the incidence of selection on the organism as a whole, with the elimination of those which bear the seeds of discord therein, is perhaps better grasped to-day; and the nursing of variations by modifications may link acquired and congenital harmony in a serviceable manner. There is nothing here to lead us to reject natural selection. Nor, as some of us believe, is there anything in Mendelian research which points in that direction. Indeed, the more clearly one realises that all the experimental work, Mendelian and other, which has helped us so much, is based on selection, the more one feels that there is some selective process in nature, other than human choice—some purely natural law in terms of which success or failure in the battle of life may be interpreted. And this is what we should mean by natural selection.

We commonly make the word "selection" do duty with rather a wide range of signification. Let us therefore distinguish. There is, first, fully conscious and quite definitely intentional selection where we exercise true choice, having clearly in view some end to be attained in the future. Human life at its highest and

Selection by Choice.

best involves such deliberate selection in numberless ways. Among competing ideals we choose this or that for realisation so far as in us lies. We conceive an ideal self in relation to an ideal community, and we try to "play the game." Among such ideals is the eugenic ideal; and in so far as there is a real desire for its attainment, a man, in selecting a partner for life, looks forward, not only to a well-ordered home and happy family life, but to rearing good citizens of the Jonathan Edwards type, or some such worthy type. Thus, among super-mediocrities, like mates with like of deliberate intent and with forethought, partly at least to the end of producing a pure line, or, as the plain man would more probably put it, of maintaining the best traditions of the family to which he belongs and of which he is proud. This is the first and highest form of selection. Secondly, there is a form which is much less fully conscious or deliberately intentional. The choice is, as we say, more instinctive. In trivial matters we choose this or that course of action a hundred times in a day without carefully weighing the consequences. A man of the Juke type mates with a woman of much the same type; but not presumably with the aim of perpetuating that type. Like does consort with like; but just because that is what he feels inclined to do. He does not intend to establish a pure line; indeed, he takes little or no thought for the future of mankind when his days are run. The eugenic ideal of a good stock never enters his head. Without falling wholly to their level he mates as the animals mate because he "feels like" doing so. This second form of selection—one might call it the animal form—is psychological, but at a lower psychological level than

Selection by Preference.

the first. It is psychological in so far as it depends on inclination and involves some preference; it is at a lower psychological level, because the further significance of the act to which inclination prompts is probably beyond the grasp of the animal mind, and is but little dwelt on by those among us whom, for that very reason, we call improvident. Like little children, these sub-mediocrities live to a large extent in the passing moment and are swayed by the impulses of that moment.

Now both of these forms of selection, the higher and the lower psychological form, though each in its own way leads to selective segregation, like consorting with like, need not involve—though of course it may involve—elimination. No one need fail to find a mate and to rear offspring. Apart from differential fertility (under 4 and 5) there may be no change in the hereditary "mode" of a plotted curve. The line of the Edwards's and the line of the Jukes are selectively segregated; but both lines are comprised within the social stock; and, again, apart from different rates of increase in numbers, both contribute their quota to the statistics which must be entered on our curve.

Selection by Elimination.

The third form of selection need not be conscious at all—indeed, it is typically unconscious. It obtains in the world of plants, as in the animal kingdom, and, in a measure, among human folk. It is what we call natural selection; and its keynote is elimination—not purposeful elimination such as the breeder of stock intentionally plans, for this depends on conscious and deliberate choice of those to be excluded from mating; but a quite unintentional elimination leading to the mere matter-of-fact survival of those which are not eliminated.

I said above that the animal form of conscious selection depends on inclination with some preference. Now in normal and natural animal life (apart from enforced changes of habitat and environment) the conscious inclination to eat this or that, or to do this or that, or to mate with their kind, is consonant with the well-being of the animal or the continuance of the species. It is difficult to see how this consonance could be brought about, through natural means, save by the elimination of those whose inclinations failed to accord with their welfare and the preservation of the species. For if the inherited impulse were to eat poisonous stuff and to do that which is harmful; if there were no deep-rooted inclination to mate and to nourish and protect the young; what chance would there be of the survival of a vigorous and prolific stock? Perverted instinctive dispositions would inevitably lead to destruction, while those whose instinctive dispositions were consonant with welfare would survive and would transmit like dispositions.

Cumulative Effects of Human Dispositions.

It may be urged, however, that in mankind there *are* perverted dispositions; in some people, for example, a strong inclination to drink to excess; and that this is not only harmful to the individual, but may poison the germ, or the fœtus in the womb, and entail constitutional weakness, nervous disorder, and perhaps insanity. In this way the effects of drink may be cumulative. Given a liking for alcohol cunningly wrought up so as to appeal to the palate; given enjoyment of its exhilarating effect; given lack of power to resist a craving for more and more of this enjoyment; excessive indulgence itself lowers the power of resistance and increases the imperative craving; and

this leads on to still more excessive indulgence; the whole organism may be soaked with the poison, and with it the germinal substance; and from this poisoned germ a still weaker person may be developed. How is it, then, that an inclination leading onwards to such ill-effects is present in man? Is there here that consonance of inclination and welfare which natural selection is supposed to establish? Obviously there is not; or, at all events, in many cases it has not been attained. But consonance is brought about through persistent natural selection in a natural and normal environment. As biology reckons time, alcohol is a late and artificial product of human ingenuity to tickle the palate, and, even in slight excess, to loosen the bonds of self-restraint. Figuratively speaking, natural selection has had neither the time nor the opportunity to eliminate those whose unchecked inclination leads to the reverse of welfare. There is such elimination in progress; but we do all that we can to save the drunkard from the full effects of his folly; and often in saving him (and ought we not to try to do so?) we are fostering the transmission of that inclination which is the root of all the evil. We are on the horns of a moral dilemma. In duty to the individual we should seek to reclaim him; in duty to the community we should seek to restrain him from handing on to the future a disposition which is perhaps held in check but is not eradicated.

A Moral Dilemma.

Dr. Archdall Reid, in an interesting discussion of this subject, contends that certain communities which have had unusually free and ready opportunities of indulging their craving for alcohol are remarkably temperate. They are now temperate, he urges, because the intemperates—those whose inborn proclivities led them to

excessive indulgence—have drunk themselves to death, leaving those with moderate appetite for alcohol to be the parents of a temperate race. He contends, too, that in China, where the opium habit has long been prevalent, the ill-effects of this habit are far less marked than they are in Burmah, where opium has but recently been introduced. The inference he draws is that, in the former country, those who indulged to excess have been, in large measure, already eliminated; whereas, in the latter country, this process of elimination is still in progress, as we may see from the lamentable condition of those who are on the high road to extinction. Now if these contentions receive confirmation from a further consideration of the facts, they serve to illustrate natural selection in human life.

The Survival of the Fit.

There is little doubt that in communities in which certain forms of disease have been prevalent for many generations there is less susceptibility to infection than in peoples among whom they have not been prevalent, and that these diseases assume a lighter and less virulent form. Measles, newly introduced, in Fiji (1876) and in Samoa (1893), proved in each case to be a "devastating plague." The people of New Guinea suffered terribly from whooping-cough in 1903. With many of us these are regarded as passing infantile maladies. This may be due to partial immunity acquired by individuals and transmitted to offspring; but it is more probable, as Dr. Archdall Reid contends, that susceptible persons have been steadily eliminated, leaving those as survivors who are less susceptible, and who recover from attack. When this stage is reached natural selection can carry the process no farther, since elimination has then ceased.

In these and other analogous ways natural selection

obtains and is a factor in the evolution of man, in spite of the efforts of the doctor and the temperance advocate to combat such elimination. But, when we turn to the higher mental characters, it is questionable whether progress in civilised life is attributable in any large measure to the elimination of sub-mediocrities. They remain with us and of us. No doubt, under competition, they are forced to take subordinate places even in the most democratic hierarchy. But by social effort we seek to supply the lowest of them with at least the bare means of subsistence; we prevent, so far as possible, their elimination. Only in tentative ways do we feel justified in restraining them from contributing too freely to the number of the rising generation.

CHAPTER VII.

OUR SOCIAL HERITAGE.

I distinguished between three forms of selection. There is (1) fully conscious selection with deliberate choice; for this we can assign a reason in terms of an end which we have in view. There is (2) selection of that which appeals to some inclination depending on an innate or acquired disposition; thus an animal, in this sense, selects his proper food because he "feels like" eating that and not other things, he knows not why. And there is (3) natural selection in which there is no true choice. It is the name we apply to a process of elimination by which the fit survive. Now the first involves a high order of intelligence; the second involves a lower order of intelligence; the third need not involve any intelligence, for example, in the plant-seeds, which develop in marshy ground but fail to develop on a dry soil, or vice versa. But though natural selection is an unintelligent process, still through this process intelligence itself may have reached its present stage of evolution on our earth. That is to say, as we have already seen, the consonance of inclination and welfare may be due to the survival of those in which it obtained, and the elimination of all others; and those organisms, such as man himself, in whom the higher form of intelligence is present, may have survived just because such intelligence rendered them more fit to survive than the stupider folk who have suffered elimination. But they have survived, in that case, not because they were

selected for survival (in sense 1 or 2), but simply because they proved the fittest to survive.

Parenthetically a word of warning may be offered with regard to this expression "fittest to survive." Strictly speaking the fittest to survive are just those which do survive. This is the only ground on which we call them the fittest. They are not necessarily fitter that others in any *other* respect than that which secures them from elimination. We must be on our guard, too, against what one may call a pendulum method of definition, exemplified when we say that the strongest motive prevails. Why does it prevail? Because it is the strongest. How do we know that it is the strongest? Because it prevails. And so on, to and fro. Thus we must be careful not to say: This survives because it is the fittest; and we know that it is the fittest because it survives. We are here merely looking at the same fact, now from the one end and now from the other end of the pendulum swing of our thought.

Pendulum Definitions.

Natural selection then depends on matter-of-fact elimination, with the survival of those which are not thus eliminated and which we call the fittest because they do survive, e.g., from measles or whooping-cough. Of course they *may* be more fit in certain other respects. Those who recover from measles may be morally and intellectually superior to those who succumb; but there are no statistics to show that they are. It may be said, however, that those who survive under the elimination effected by alcohol are morally and intellectually superior to the unfortunates who drink to their death. Yes. But here self-control, itself moral and intellectual, is itself one factor in survival. The two main factors are (1) an inclination to drink, and (2) the keeping of

this inclination under restraint. Natural selection, given free play, would reduce the strength of (1) and increase the strength of (2), in those who are temperate by nature. Self-restraint in this matter may well be correlated with self-restraint in other matters, and the survivors may well be generally, and not only in this respect, stronger in intellect and in moral fibre.

Let us then accept natural selection as, in such and other such ways, a factor in human progress; but *only* in so far as there is actual elimination of the "unfit." Even so, it is questionable whether, in the present evolution of civilised man, natural selection is a potent influence which, in any large measure, contributes to the advancement of mankind. No doubt moral and intellectual failures are to some extent weeded out. But we do all that we can do to prevent their suffering this extreme penalty of incapacity. We feel that it is right that the strong should help the weak and shield them from the incidence of natural elimination.

We have proceeded on the method of isolating the several factors in an exceedingly complex problem. We have asked what will be the outcome if we consider this or that factor in abstraction from other co-operating factors. Let us now, in continuance of this method, assume for the sake of discussion that natural selection plays little part in the present moral and intellectual evolution of civilised man; and, further, that the effects of nurture are not inherited. The question then is: What on these assumptions, is the salient factor in human progress? We must revert to that which was numbered (6) in my last chapter—the improvement of the individual under nurture, i.e., under better conditions, fuller training and education; but we must look at the

The Chief Factor in Human Progress.

matter from a rather different point of view. From the former point of view an individual, say X, inherits a given capacity of reaching a certain level under training and education; and his inborn power may be developed, under the most favourable conditions, up to, or nearly up to, but obviously not *beyond*, the limits assigned to his hereditary nature. He thus becomes well adapted, or more technically, accommodated, to his environment. Perfect accommodation, were it reached, is again a limit to his progress. Thus there is a limit set by his inborn capacity, and a limit set by the environing conditions to which he may, at best, be fully attuned. Now we are assuming that the former limit cannot be overpassed; beyond his innate capacity he cannot go. But what about the latter limit? So long as the environment remains unchanged, that limit too cannot be overstepped. But does this environment remain unchanged? Is a man's environment to-day just what it was in the times of the Plantagenets or the Tudors? May not—does not—the environment itself show progressive evolution? And may there not be—is there not—progressive accommodation to a progressively evolving environment?

What is Environment?

What is the environment of any given person? I suppose the house in which I live is part of my environment. So is the steamship, train, or electric car by which I travel; the golf-course at which I play; the museum and art gallery which I visit; the cathedral in which I worship; the university in which I teach. The university library, or that of the British museum, is, or may be, part of my environment—one not only of bound volumes and printed pages, but of recorded knowledge with which, if I will, I may come

into living touch. Past thought is here rendered present; and by telegraph and newspaper, distant events are rendered near. By the environment, as I am using the term, I mean anything and everything by which body or mind, physical or mental process, may be moulded or fashioned. And it is in this sense that I speak of the environment as undergoing progressive evolution. This environment is both the product of, and the abiding embodiment of, human selection in its first and highest form. In it human ideals have been realised; through it the realised ideals have been handed down to us. Man is not only moulded by this environment, he progressively moulds it for better or for worse. Hence each one of us, with strictly limited capacity, may reach to-day a level of attainment far higher than would have been possible for us had we lived in the times of the Plantagenets or the Tudors. All that is embodied in this environment is our social heritage, not transmitted through organic heredity, but handed on by what is spoken of as tradition in a comprehensive usage of the term. And by far the most important factor in the moral and intellectual evolution of man is that which I here seek to emphasise. There is, of course, nothing new in what I have said. Buckle, writing in 1858, says in his "History of Civilisation," "Whatever the moral and intellectual progress of man may be, it resolves itself not into the progress of natural capacity, but into a progress, if I may say so, of opportunity; that is, an improvement in the circumstances under which that capacity after birth comes into play. Here then is the gist of the whole matter. The progress is one not of internal power but of external advantage." So, too, Professor Ritchie, in his "Darwinism and Poli-

Progress of Opportunity.

tics," says: "Might we not define civilisation in general as the sum of the contrivances which enable human beings to advance independently of heredity?"

Let us turn to the organic world[1] that we may discover the germs from which this kind of evolutionary progress has developed, and let us ask what a presumably unconscious organism, such as a plant, inherits. In the first place it inherits a more or less well-defined form, structure, and habit of growth. In the second place it inherits, in greater or less degree, such plasticity as allows of accommodation to environing conditions. The characters which fall under the first head are congenital; those which fall under the second head are acquired. Both the congenital definiteness and the innate plasticity which leads to accommodation are variable; and the method of progress is through the natural selection of favourable variations or mutations. Among the higher animals heredity plays a like part, but plasticity takes on a higher form through conscious selection of our second order. Imitation and intelligence render possible a more varied and more complex accommodation to circumstances especially where the animals live in social communities; we have the beginning of tradition; we see the earlier and simpler forms of social inheritance running parallel with organic heredity; we have the initial stages of a transference of evolution from the organism to the environment which, in some measure, it creates for itself.

Picture one of the higher animals possessed of that innate plasticity which a primitive form of sympathy, a tendency to imitation, and some intelligence imply.

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[1] In what follows I utilise some passages I wrote in the *Monist* more than twenty years ago.

Suppose such an animal born within a community of his kind. He sees around him the social life of his species. Through sympathy and imitation he is impelled to enter into and become an active participator in this life. His quick intelligence enables him to follow, though he may not be able to see the reason of, the moves in that game, into which he instinctively enters. If above the average of his fellows he may stumble upon new moves, and learn by experience to repeat them, if they bring satisfaction; through sympathy and imitation others follow suit. The game of life is raised to a higher level; the better procedure becomes traditional in the species. The next generation are born into a community where life's game is played to better advantage. Even if endowed with no inherited increment of native capacity the members of this generation are none the less heirs to a better heritage, that of the improved traditions of their race. Continuity and progress are thus rendered possible in ways different from, though arising out of, those which are seen in the organic heredity that suffices for the plant and the simpler forms of animal life. Imitation supplies the element of continuity; intelligence that of progress. All that organic heredity has to do is to maintain the standard of these two essential pre-requisites. Intelligence will hit on better moves in the hazardous game where life is often at stake; imitation will enable even mediocrity to profit by them, and succeeding generations will be the gainers.

The Making of Tradition.

Such an animal, raised to a yet higher level, is man. In his civilised state organic evolution, conditioned by heredity and endorsed by natural selection, though still

in evidence, has in large measure been supplemented by evolution of the social environment, rendered continuous by forms of tradition which are deliberate and intentional. Between the lowly animals in which organic evolution must suffice, and the Englishmen of to-day among whom the moral and intellectual evolution is of the social type, lie many grades in which the two methods overlap. The transition has been gradual with smaller or larger mutational steps. But as man became more distinctly human, and as civilisation advanced, progress through opportunity afforded by the growing social heritage slowly but surely waxed in range and importance.

Evolution of the Social Environment.

Mr. Balfour has emphasised this in the stress that he has laid on the influence of authority in human life. "It is Authority rather than Reason which lays deep the foundations of social life; it is Authority rather than Reason which cements its superstructure." Now what is this authority but the articulate voice of human tradition? But in authority, though we may see in it the bond of continuity, we do not find the promise of progress. The authority of to-day is not, and should not be the authority of yesterday. If it were, social evolution would be impossible. While authority is the bond of continuity, reason, as consciously selective, is the mother of progress. Under the influence of authority man enters into his social heritage, and falls heir to the achievements of his race. Is he to rest content with handing on this heritage unimpaired? No. Much of it indeed he must leave unmodified—for life is short and the inheritance of vast extent. But he chooses out—with fully conscious selection—some larger or smaller plot of ground in the great estate, and says:

"Here will I dig, and sow, and reap. This corner of the estate shall be the better because I have lived and worked therein." In other words, selecting his field of labour, he critically tests, modifies, and if it may be enriches, the heritage which shall pass to succeeding generations. He not only hands on authority, but he becomes *an* authority—one who makes history. Of course it is only the gifted few who leave their impress on the social heritage—who are in the highest sense teachers of mankind. But though teachers be few, their pupils are many. And the outcome of social tradition is cumulative; every stroke of good work well done tells. The woven tapestry of our environment grows under the hand of philosophers, artists, men of science, inventors, and those who, in humbler spheres, fill in a background of all that contributes to social well-being. How far any one of us makes this environment *his* environment, that with which he is in vital touch, depends upon his innate capacity to utilise it, and the training which enables him to make the best of it. The aim of eugenics is to raise the average level of this inborn capacity, or at any rate to prevent its falling through undue increase in the number of sub-mediocrities. The aim of education, broadly considered, is to enable each pupil of the State to come into living contact with this environment up to the limits of his capacity. A further social aim is to afford to each the opportunity to use what he inherits by nature and what he acquires through nurture, to the best advantage not only for himself but for the community.

No Good Work is Wasted.

Thus, although the average of capacity may stand at no higher level—may even stand at a lower level—than it did in the days of the Tudors, social evolution still

continues and thus there is promise of progress so long as that capacity is employed in building up the environing structure of civilised society. Each generation of builders is working at a higher level with the better tools their predecessors have fashioned. And this structure is the product, not of the average intelligence, but of the best thought and endeavour of each succeeding age. But it forms the mould in which mediocrity is cast. For one of the most important of the features which distinguish social evolution from the merely organic evolution which we see among the lower animals is the predominant part which is played by the "fittest," now used in a comprehensively human sense, in raising the level of the "less fit." They enrich the intellectual, moral, and æsthetic atmosphere which all may breathe.

Evolving an Atmosphere.

This analogy may serve again to illustrate the transference of evolution from man as an organism to the environment which is his social heritage. The lungs of the mind are perhaps no better than they have been in many generations, but the air they take in is richer in mental oxygen. If the city clerk to-day has more intellectual vigour than the man who occupied the stool a few generations ago, it is not because he has better mental lung-power, but because more mental oxygen courses through his veins. It is not the lung-power but the atmosphere which is now being evolved. But since a richer atmosphere brings more vitality, the intellectual vigour of the average man is heightened through the purer and richer air which is his through our social heritage.

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